*भारतीय मानक*
*Indian Standard*

**IS 5321 : 2022**

# सोडा चूने के लिए विशिष्टि (कार्बन डाइऑक्साइड सोखनेवाला)

*( पहला पुनरीक्षण )*

# Specification for Soda Lime (as Carbon Dioxide Absorbent)

*( First Revision )*

ICS 71.060

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**September 2022** **Price Group 7**

Inorganic Chemicals Sectional Committee, CHD 01

## FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Inorganic Chemicals Sectional Committee had been approved by the Chemical Division Council.

Soda lime is a mixture of variable proportions of calcium hydroxide, sodium hydroxide and water. Carbon dioxide absorbents are used in mining applications such as breathing apparatus and refuge chambers. Absorbents can vary depending on the designated use, manufacturing techniques and chemical composition.

This Indian standard was first published in 1969. In this revision, the requirements for absorbency (to check the capacity of soda lime to absorb minimum required amounts of $CO_2$), flow resistance (to check the resistance to air-flow that soda lime has in a packed space (as in closed-circuit re-breathers), contaminants (to identify whether *p*H indicators are contaminants in breathing apparatus soda lime), carbonate content (to check the maximum permissible limit of formation of other compounds in the $CO_2$ absorber), friability (to check formation of dust due to friction in packed soda lime) and performance tests (on-field using equipment to measure output) have been incorporated. In addition to this, few changes in the limits of existing parameters like particle size and dust, moisture content and activity have also been made in light of the requirements of the industry.

In the preparation of this standard, considerable assistance has also been derived from BS 8618 : 2015.

The composition of the committee responsible for formulation of this standard is given at Annex D.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

# *Indian Standard*

# SPECIFICATION FOR SODA LIME (AS CARBON DIOXIDE ABSORBENT)

*( First Revision )*

## 1 SCOPE

This standard prescribes the requirements and the methods of sampling and tests for soda lime intended primarily for use as carbon dioxide absorbent in respirators.

**1.1** It does not include the material used for medical purpose in closed-circuit anaesthetic apparatus.

## 2 REFERENCES

The Indian Standards given below contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards.

| *IS No.* | *Title* |
|---|---|
| 296 : 1986 | Specification for sodium carbonate, anhydrous (*third revision*) |
| 1070 : 1992 | Reagent grade water (*third revision*) |
| 4905 : 2015 | Random sampling and randomization procedures (*first revision*) |

## 3 REQUIREMENTS

### 3.1 Description

Soda lime shall be in the form of granules free from foreign matter. It shall be sieved and blended so that the size grading of the finished product is as specified in Table 2.

**3.2** The absorbent material will contain no indicators. An indicator will be deemed to be present if there is a colour change observed during the carbon dioxide absorbency test (*see* **A-5**).

**3.3** The material shall comply with the requirements specified in Table 1 when tested according to the methods prescribed in Annex A, as stated in col 4 of the Table 1.

**Table 1 Requirements for Soda Lime**

(*Clause* 3.3)

| Sl No.<br>(1) | Characteristic<br>(2) | Requirement<br>(3) | Test Method<br>(4) |
|---|---|---|---|
| i) | Particle size | Refer Table 2 | Annex B |
| ii) | Moisture, percent | 14-20 | A-3 |
| iii) | Hardness, percent, *Min* | 75 | A-4 |
| iv) | Absorbency, percent, *Min* | 19 | A-5 |
| v) | Activity, mins, *Min* | 60 | A-6 |
| vi) | Flow resistance, mbar, *Max* | 1.2 | A-7 |
| vii) | Contaminants | None | A-8 |
| viii) | Carbonate content, percent by mass, *Max* | 6.0 | A-9 |
| ix) | Friability | Refer Table 3 | A-10 |
| x) | Performance testing, h, *Min* | 4 | A-11 |

### 3.4 Size Grading

The granule size and dust load of the soda lime must follow the specifications given in Table 2, when tested using a set of standard sieves and a mechanical sieve shaker, as described in Annex B-1.

**Table 2 Particle Size**

(*Clauses* 3.1 *and* 3.4)

| Sl No.<br>(1) | Granule Size<br>(2) | Limit<br>(3) |
|---|---|---|
| i) | Retained on 5.60 mm | < 1.0 percent |
| ii) | Passing through 5.60 mm and retained on 4.75 mm | < 7.0 percent |
| iii) | Passing through 4.75 mm and retained on 2.00 mm | BALANCE |
| iv) | Passing through 2.0 mm and retained on 0.60 mm | < 15.0 percent |
| v) | PAN | < 0.5 percent |

## 4 PACKING AND MARKING

### 4.1 Packing

Soda lime shall be supplied in clean, dry, air tight packaging or as agreed to between the purchaser and the supplier. The containers shall not be opened until required for use and shall not remain open for a period longer than required for taking out the material.

### 4.2 Marking

**4.2.1** Each package shall be marked with the following information:

a) Name of the material;
b) Name of the manufacturer and address;
c) Net weight of contents;
d) Lot number;
e) Expiry date; and
f) Hazard warning symbols.

**4.2.2** *BIS Certification Marking*

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed there under, and the products may be marked with the Standard Mark.

## 5 SAMPLING

The method of obtaining representative samples from a batch of material, number of tests to be performed, and the acceptance criteria to demonstrate conformity with the specification is prescribed in Annex C.

# ANNEX A

(*Clause* 3.3, *Table* 1)

## A-1 QUALITY OF REAGENTS

Unless specified otherwise, pure chemicals and distilled water (*see* IS 1070) shall be used in tests.

NOTE — 'Pure chemicals' shall mean chemicals that do not contain impurities which affect the results of analysis.

## A-2 PREPARATION OF SAMPLE

Mix the sample by gently tumbling a suitable bottle containing soda lime several times. A sub-sample can then be removed for testing.

## A-3 DETERMINATION OF MOISTURE

### A-3.1 Method

This will be measured by heating a set weight of soda lime (*min* 10.0 g) to a pre-determined temperature unit (150 ± 2°C) until the residue weight remains constant. Heating is to be performed under inert conditions using nitrogen or argon gas.

Equipment required — Automatic infra-red moisture balance.

### A-3.2 Calculation

$$Percent\ Moisture = \left(\frac{W_1 - W_2}{W_1}\right) \times 100$$

where

$W_1$ = initial mass of soda lime; and

$W_2$ = mass of soda lime after heating.

## A-4 DETERMINATION OF HARDNESS

**A-4.1** This test measures the ability of the material to resist breaking and reduce dust formation due to attrition.

### A-4.2 Method

A portion of soda lime is sieved in order to obtain a specific size fraction. This portion (50.0 ± 0.2 g) is placed into a hardness pan (diameter 20 cm with a concave brass bottom, which is 7.9 mm thick at circumference and 3.2 mm thick at centre with inside spherical radius of curvature 109 cm) along with 15 steel balls of 7.9 mm diameter. The mixture is shaken on for 30 min at the pre-set frequency of oscillation of 285 ± 3 cycles per min. The steel balls are removed, then the pan contents are placed onto a sieve of the same size as that which it originated from. The sieves are tapped for a further 3 min, then the material retained on the sieve is weighed.

### A-4.3 Calculation

Percent Hardness = 100 × mass of sample remaining/ mass of material placed in hardness pan.

Acceptance criteria — not less than 75 percent of material is retained on the sieve.

## A-5 DETERMINATION OF CARBON DIOXIDE ABSORBENCY

### A -5.1 Method

A U-shaped tube is filled with 10.0 g of soda lime. A side arm is connected to 5.0 g of anhydrous calcium chloride. This is connected to a supply of carbon dioxide. The gas is passed through the tube at a rate of 75 ml/min for a period of 20 min. The tube is then disconnected, and stoppered to prevent the entry of any additional air, allowed to cool to room temperature and weighed.

### A-5.2 Equipment

A calibrated balance capable of weighing to an accuracy of at least 0.1 g.

### A-5.3 Acceptance Criteria

The weight gain should be not less than 19 percent.

## A-6 DETERMINATION OF CARBON DIOXIDE ABSORBENT ACTIVITY

### A-6.1 Method

A mixture of 5 percent carbon dioxide is passed at a constant rate through a bed of soda lime, which is housed in a tube of specified dimensions. The outlet is analysed for carbon dioxide. The time taken from the start of the test until the carbon dioxide outlet concentration reaches 0.5 percent is measured. This period is defined as the activity of the absorbent.

**A-6.2** The test apparatus is set up as shown in Fig. 1.

**A-6.3 Test Gas Mixture**, 5.0 ± 0.05 percent carbon dioxide in air.

### A-6.4 Carbon Dioxide Analysers

The carbon dioxide level must be monitored by a closed loop analyser. These must be calibrated using certified calibration gas mixtures of $CO_2$ in nitrogen.

### A-6.5 Activity Tube

The glass tube, as shown in Fig. 2, has a 30 mm internal diameter, and is scored for 105 ml.

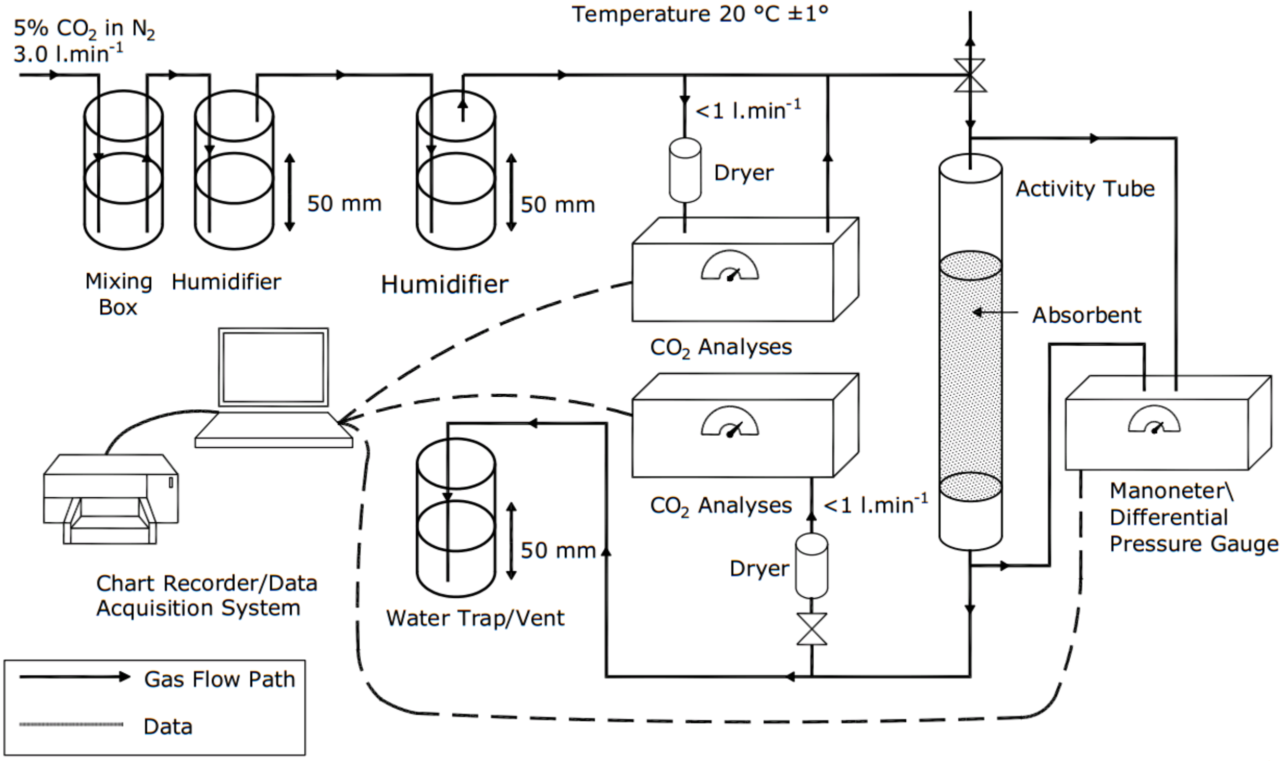

FIG. 1 SCHEMATIC CARBON DIOXIDE ABSORBENT TEST RIG

### A-6.6 Method (Continued)

Locate the activity tube, as shown in Fig. 2, into the base of a snow storm filler as detailed in Fig. 3 and Fig. 4. A sample of soda lime is transferred into the activity tube with gentle tamping until the 105 ml filing mark, ensuring that the granules fill the tube evenly to the line.

A flow of test gas mixture (3.0 l/min) at 20°C is passed through a humidifier, before entering the activity tube. The tube is positioned vertically with gas flow from top to bottom. At the outlet, a portion of the effluent is drawn off and after passing through a drying agent, is analysed *via* a carbon dioxide detector. The data should be recorded on a data acquisition system. The test is complete once the output level of carbon dioxide reaches 0.5 percent.

Time for $CO_2$ output level to reach 0.5 percent $\geq$ 60 min.

NOTE — The tests to determine the activity shall be conducted at 20 ± 2°C.

## A-7 DETERMINATION OF FLOW RESISTANCE

### A-7.1 Method

A mixture of 5 percent carbon dioxide is passed at a constant rate through a bed of soda lime, which is housed in a tube of specified dimensions. The outlet will contain carbon dioxide. A differential pressure across the activity tube is to be recorded with activity test-gas flowing and no absorbent in the activity tube.

### A-7.2 Equipment

The test apparatus is set up the same as for activity test. A differential pressure monitor with minimum accuracy of ± 0.01 mbar is connected to the top and bottom of the activity tube.

**A-7.3 Test Gas Mixture**, 5.0 ± 0.05 percent carbon dioxide in air.

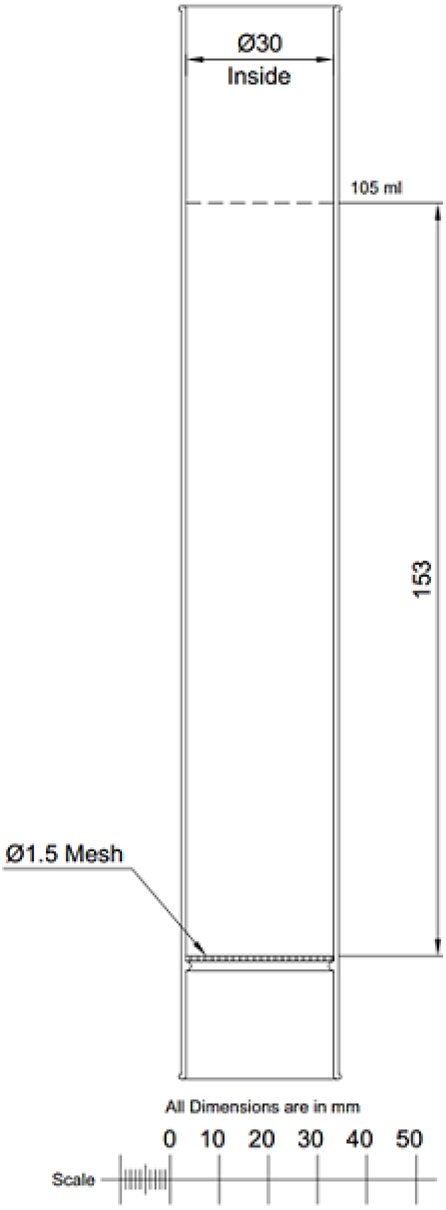

FIG. 2 ABSORBENT ACTIVITY TUBE

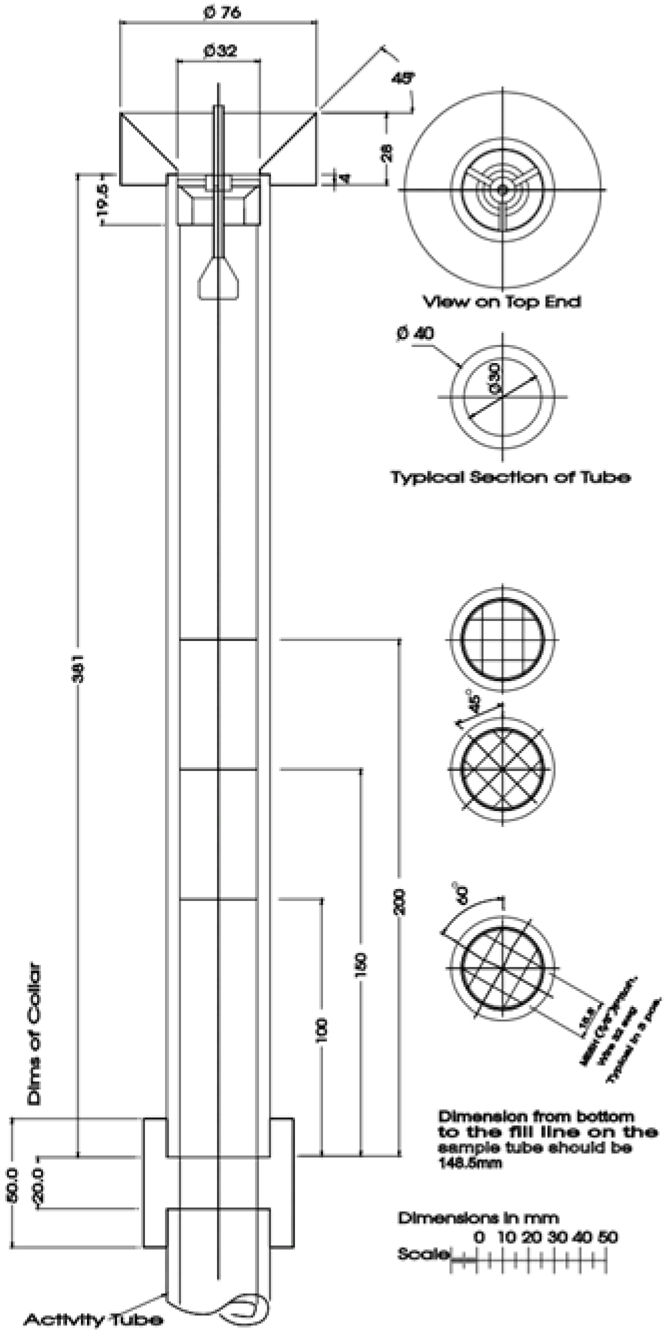

FIG. 3 SNOW STORM FILTER FOR ACTIVITY TUBE

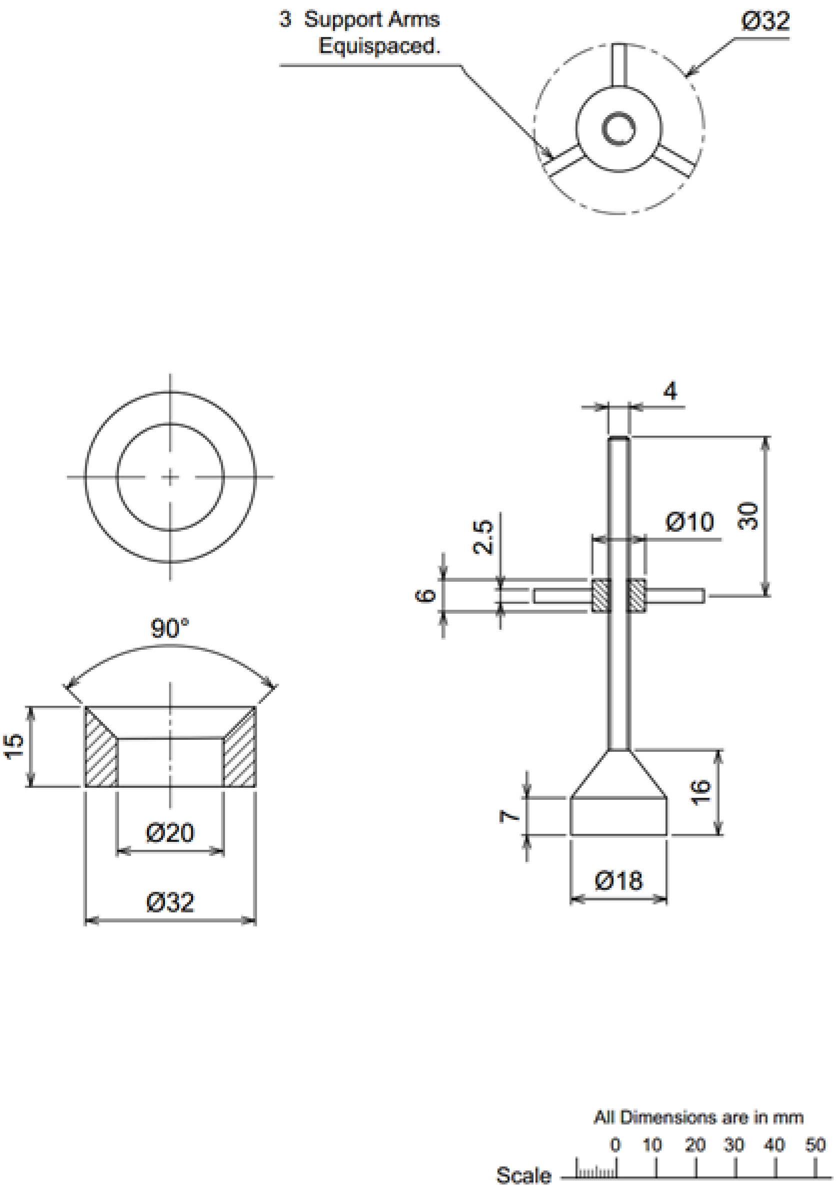

FIG. 4 SNOW-STORM FILTER THROAT DETAILS

**A-7.4** Maximum differential pressure shall be recorded in a computerized system.

### A-7.5 Activity Tube

The glass tube, as shown in Fig. 2, has a 30 mm internal diameter, and is scored for 105 ml.

### A-7.6 Result

Flow resistance = maximum differential pressure-baseline differential pressure.

The difference should be ≤ 1.2 mbar.

## A-8 DETERMINATION OF CONTAMINANTS

### A-8.1 Scope

Colour change during tests with reagents signifies the presence of indicators in soda lime, which is not ideally suited.

### A-8.2 Method

Few granules of soda lime on a white filter circle, add a few drops of 10 percent ethanoic acid solution.

### A-8.3 Result

Colour change indicates presence of indicators. Colour change during activity test also indicates presence of Indictors.

## A-9 DETERMINATION OF INITIAL CARBONATE CONTENT

### A-9.1 Apparatus

The apparatus shall consist of the following components assembled as given in Fig. 5:

**A-9.1.1** *Funnel (A)*

**A-9.1.2** *Two-way Cock (B)*

**A-9.1.3** *50-ml Flask (C)*

**A-9.1.4** *Levelling Bottle (D)*

**A-9.1.5** *Condenser Tube (E)*

**A-9.1.6** *Water Jacket (F)*

**A-9.1.7** *Compensator Tube (G)*

**A-9.1.8** *Gas Burette (H)*

**A-9.1.9** *Manometer (J)*

**A-9.1.10** *Sodium Hydroxide Bubbler (K)*

**A-9.1.11** *Valve (L)*

**A-9.1.12** *Three-way Cocks (M, N, P, Q)*

**A-9.2** The compensator tube is used to correct automatically for the changes in barometric pressure and temperature by balancing the pressure in the burette against that in the compensator tube. The manometer is used when balancing the pressure in the burette against that in the compensator tube.

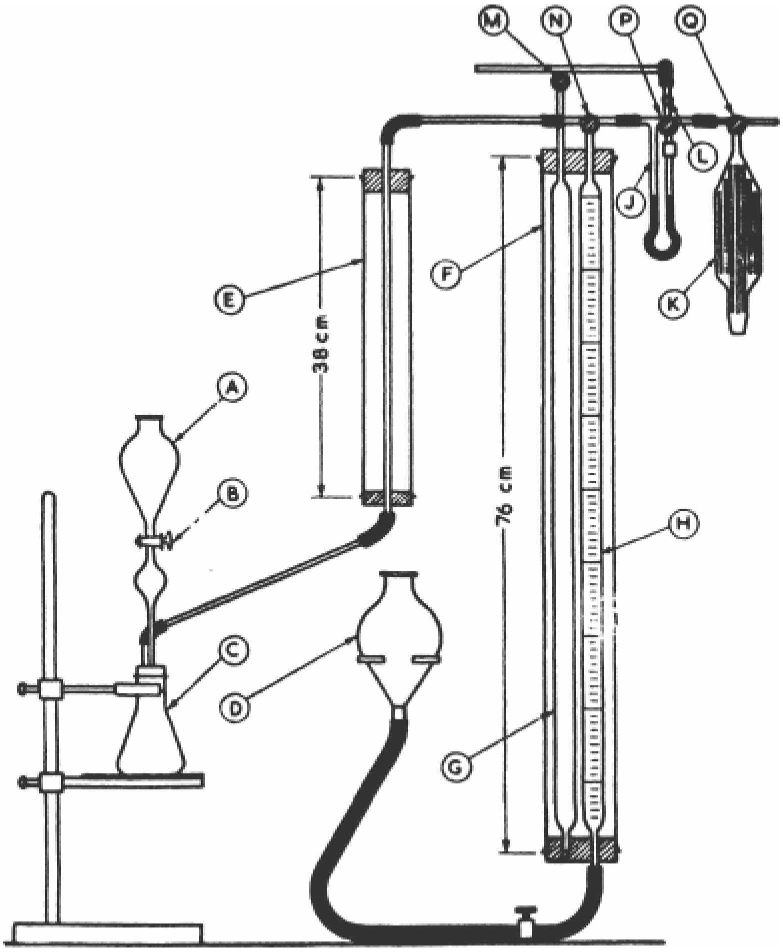

FIG. 5 ASSEMBLY OF APPARATUS FOR DETERMINATION OF CARBONATE

### A-9.3 Procedure

**A-9.3.1** Weigh accurately about 3 to 4 g of finely powdered lime and place the sample in flask C. Also add a piece of iron wire about the size of a pin head and a drop of methyl orange indicator. Add water until the flask is about three-quarters full.

**A-9.3.2** Open cock M for a moment so as to connect the compensator tube G to the atmosphere and turn it half anti-clockwise so as to connect the compensator tube with the manometer J. Open cocks P and Q to the atmosphere and level the mercury columns. Turn cocks P and Q anti-clockwise so as to connect them with the capillary tube leading to the flask C. Fill the burette H completely with acidulated water by connecting the cock N with the capillary tube leading to the flask and raising D. Connect C and close cock B. Pour excess of concentrated hydrochloric acid into A.

**A-9.3.3** Now open cock B fully and lower D so as to let the acid drop slowly into C until very slightly in excess. Close B and fill D nearly full with water and lower D to the full extent. Heat the contents of C to boiling and continue boiling very gently for at least 3 minutes. Remove the burner and open B immediately until the water from C fills the capillary up to N by lowering D if necessary. Close B and connect N with manometer and adjust the mercury columns and read burette H.

**A-9.3.4** Next turn cock P clockwise so as to connect with sodium hydroxide bubbler K and raise and lower D for three to four times repeatedly until all carbon dioxide is absorbed. Close Q when sodium hydroxide solution reaches the original mark. Connect P with H to adjust mercury levels and take the burette reading in the same manner as before. Note the temperature of water in the water jacket F and the atmospheric pressure.

### A-9.4 Determination of Factor (S)

The factor may be determined theoretically, but more conveniently by a series of actual tests on a sample of known carbon dioxide content. It is recommended that the analytical reagent sodium carbonate (*see* IS 296) be used.

**A-9.4.1** Procedure Weigh 2.00 g of the sodium carbonate, dissolve it in 25 ml of carbon dioxide free water, make up to 100 ml in a volumetric flask. Use 10 ml aliquot portions of this, measured by means of a standard pipette, for determining the amount of carbon dioxide it contains by the method given in **A-9.3**. Calculate the factor as follows:

$$S = \frac{Percentage\ purity\ of\ sodium\ carbonate \times M}{ml\ of\ carbon\ dioxide \times 240.86}$$

where

$M$ = mass of sodium carbonate present in the aliquot of sample taken for factor test.

### A-9.5 Calculation

**A-9.5.1** For large number of determinations to be carried out over a short period, calculate as follows:

a) Carbon dioxide, percent by mass $= \frac{100\,VS}{M}$

where

$V$ = observed volume, in ml of carbon dioxide;

$S$ = factor as determined, in **A-9.4**; and

$M$ = mass in g of the material taken for the test (*see* **A-9.3.1**).

**A-9.5.2** For small number of determinations to be carried out over a long period, the separate calculation of factor ($S$) may not be necessary and for such determinations, calculate the percentage of carbon dioxide as follows:

$$\text{Carbon dioxide, percent by mass} = \frac{0.007\,058\,VP}{(273+t)\times M}$$

where

$V$ = observed volume, in ml, of carbon dioxide;

$P$ = atmospheric pressure, in mm;

$t$ = temperature, in degree centigrade, of water, in the jacket F; and

$M$ = mass in g, of the material taken for the test (*see* **A-9.3.1**).

## A-10 DETERMINATION OF FRIABILITY

### A-10.1 Scope

To determine the change in size distribution of the granules following an extended period of vibration on a net of standard sieves.

### A-10.2 Apparatus

**A-10.2.1** Sieves- dry and clean (as in dust determination).

**A-10.2.2** Mechanical shaker of known frequency and amplitude of oscillation of 285 ± 3 cycles per min. Cross check 3 min before start of process.

### A-10.3 Method

Weigh and record each sieve and base pan and assemble it in order of decreasing sieve size. Distribute 100 g of absorbent on the top sieve. Close the lid and shake for minimum 60 min on the mechanical shaker.

Remove the sieves and weigh the particles retained on each. The ones lodged in the mesh shall also be weighed. The particles left on the pan shall also be weighed.

### A-10.4 Result

Report the mass of material on each sieve and the dust in the receiver as a percentage of total mass of absorbent retained in the nest of sieves.

**Table 3 Friability**

(*Table* 1)

| Sl No.<br>(1) | Granule Size<br>(2) | Limit<br>(3) |
|---|---|---|
| i) | Retained on 5.60 mm | < 1.0 percent |
| ii) | Passing through 5.60 mm and retained on 4.75 mm | < 7.0 percent |
| iii) | Passing through 4.75 mm and retained on 2.00 mm | BALANCE |
| iv) | Passing through 2.0 mm and retained on 0.60 mm | < 15.0 percent |
| v) | PAN | < 0.5 percent |

### A-11 PERFORMANCE TESTING ON-FIELD

**A-11.1 Method**

Test the soda lime as $CO_2$ absorber using 'Breathing and Metabolic Simulator' on Draeger BG4/Travox 120/BG 174/Bio-pack 240 R at any location on-field.

**A-11.2** The $CO_2$ absorbent must work in any of the systems for a minimum number of hours as shown in the table the location, with on-field conditions.

| System | Time (Minimum) |
|---|---|
| Draeger BG4 | 4 h |
| Travox 120 | 4 h |
| Draeger BG 174 | 4 h |
| Bio- Pack 240 R | 4 h |

## ANNEX B

(*Clause* 3.4)

### SIZE GRADING OF SODA LIME

### B-1 PROCEDURE

**B-1.1** Assemble the nest of sieves 5.6 mm, 4.75 mm, 2.0 mm and 0.6 mm, with the coarsest on top. Distribute a weighed quantity of soda lime (100.0 g) as received, on the top sieve. Secure the nest of sieves in a mechanical sieve shaker. Shake the assembly for exactly 5 min then remove the sieves from the shaker. Weigh the material retained on each sieve. Any particles lodged in the mesh of the sieve are brushed out and transferred to the next finer sieve.

**B-1.2** Using the figures obtained, calculate the particle size as a percentage of the sample.

**B-1.3** Table 2 lists the criteria for conformity with particle size.

# ANNEX C

(*Clause* 5)

## SAMPLING OF SODA LIME

### C-1 GENERAL REQUIREMENTS

**C-1.1** Samples should be placed in clean dry air-tight containers.

**C-1.2** Samples bottles should be kept sealed after sampling to avoid exposure to air.

**C-1.3** Sample bottles should be labelled with full details of the sample including name of material, manufacturer, date of sampling, lot number.

**C-1.4** Samples should be kept at temperatures which will not degrade the soda lime, ideally between 0 - 35°C.

### C-2 SCALE OF SAMPLING

**C-2.1** In any consignment, all the containers of soda lime from a single batch shall constitute a lot.

**C-2.1.1** To confirm conformance of the lot to a product specification, tests must be carried out on each separate lot.

**C-2.2** The number of containers (n) which shall be selected for sampling is dependent on the size of the lot (N) and will be in accordance with Table 4.

**Table 4 Number of Containers to be Selected for Sampling**

(*Clause* C-2.2)

| Sl No. (1) | Lot Size (N) (2) | No. of Containers to be Selected (n) (3) |
|---|---|---|
| i) | 1-25 | 3 |
| ii) | 26-50 | 4 |
| iii) | 51-100 | 5 |
| iv) | 101-200 | 6 |
| v) | > 201 | 8 |

**C-2.3** The containers shall be selected at random and to ensure randomness of selection, the following procedure is recommended for use:

Starting from any container in the lot, count them 1,2,………..up to *r* and so on, where *r* is the integral part of *N*/5 (*N* being the number of containers in the lot). Every $r^{th}$ container thus counted shall be withdrawn to constitute a sample till the required number of 5 containers is obtained.

# ANNEX D

(*Foreword*)

## COMMITTEE COMPOSITION

Inorganic Chemicals Sectional Committee, CHD 01

| *Organization* | *Representative(s)* |
|---|---|
| Central Salt and Marine Chemicals Research Institute, Bhavnagar | Dr Kannan Srinivasan (***Chairman***) |
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| Bhabha Atomic Research Centre, Mumbai | Dr A. V. R. Reddy<br>Dr S. N. Achary (*Alternate*) |
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| DGQA, New Delhi | Dr Gurbachan Singh<br>Shri B. S. Tomar (*Alternate*) |
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| Indian Institute of Chemical Technology, Hyderabad | Dr Praveen R. Likhar<br>Dr Rajender Reddy (*Alternate*) |
| Industrial Carbon Pvt Ltd, Ankleshwar | Shri Satyan Rohit Kumar |
| Ministry of Chemicals and Fertilizers, New Delhi | Dr Rohit Misra<br>Dr O. P. Sharma (*Alternate*) |
| Ministry of Defence (DGQA), Kanpur | Shri R. N. Aparajit |
| Molecular Products Group India Pvt Ltd, Mumbai | Shri Vikrant Patil |
| National Chemical Laboratory, Pune | Dr Darbha Srinivas<br>Dr Paresh Dhepe (*Alternate*) |
| National Metallurgical Laboratory, Jamshedpur | Dr Trilochan Mishra<br>Shri Devbrata Mishra (*Alternate*) |
| National Mineral Development Corporation Ltd, Hyderabad | Shri Rajan Kumar<br>Dr Prashant Sharma (*Alternate*) |
| National Peroxide Ltd, Mumbai | Dr Joy Anthony |
| National Physical Laboratory, New Delhi | Dr Nahar Singh<br>Dr S. P. Singh (*Alternate*) |

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| Office of the Development Commissioner (MSME), New Delhi | Dr Karthikeyan<br>Ms Anna Backiam (*Alternate*) |
| Shriram Institute for Industrial Research, Delhi | Dr (Ms) Laxmi Rawat<br>Shri B. Govindan (*Alternate*) |
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| Tata Chemicals Ltd, Gujarat | Shri Najmul Hasan Khan |
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| BIS Directorate General | Shri A. K. Lal, Scientist 'E' and Head (CHD) [Representing Director General (*Ex-officio*)] |

*Member Secretary*

Sagar Singh
Scientist 'C' (CHD), BIS

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: CHD 01 (16523).

## Amendments Issued Since Publication

| Amend No. | Date of Issue | Text Affected |
|---|---|---|
| | | |
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| | | |
| | | |

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| **Regional Offices:** | | *Telephones* |
|---|---|---|
| Central | 601/A, Konnectus Tower-1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002 | 2323 7617 |
| Eastern | 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091 | 2367 0012<br>2320 9474 |
| Northern | Plot No. 4-A, Sector 27-B, Madhya Marg Chandigarh 160019 | 265 9930 |
| Southern | C.I.T. Campus, IV Cross Road, Taramani, Chennai 600113 | 2254 1442<br>2254 1216 |
| Western | Plot No. E-9, Road No.-8, MIDC, Andheri (East), Mumbai 400093 | 2821 8093 |

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